MODEL VM-3/HO-1

INSERTION LOSS MEASURING SYSTEM

OPERATION AND MEASUREMENT PROCEDURE

WEINSCHEL ENGINEERING

GAITHERSBURG, MARYLAND

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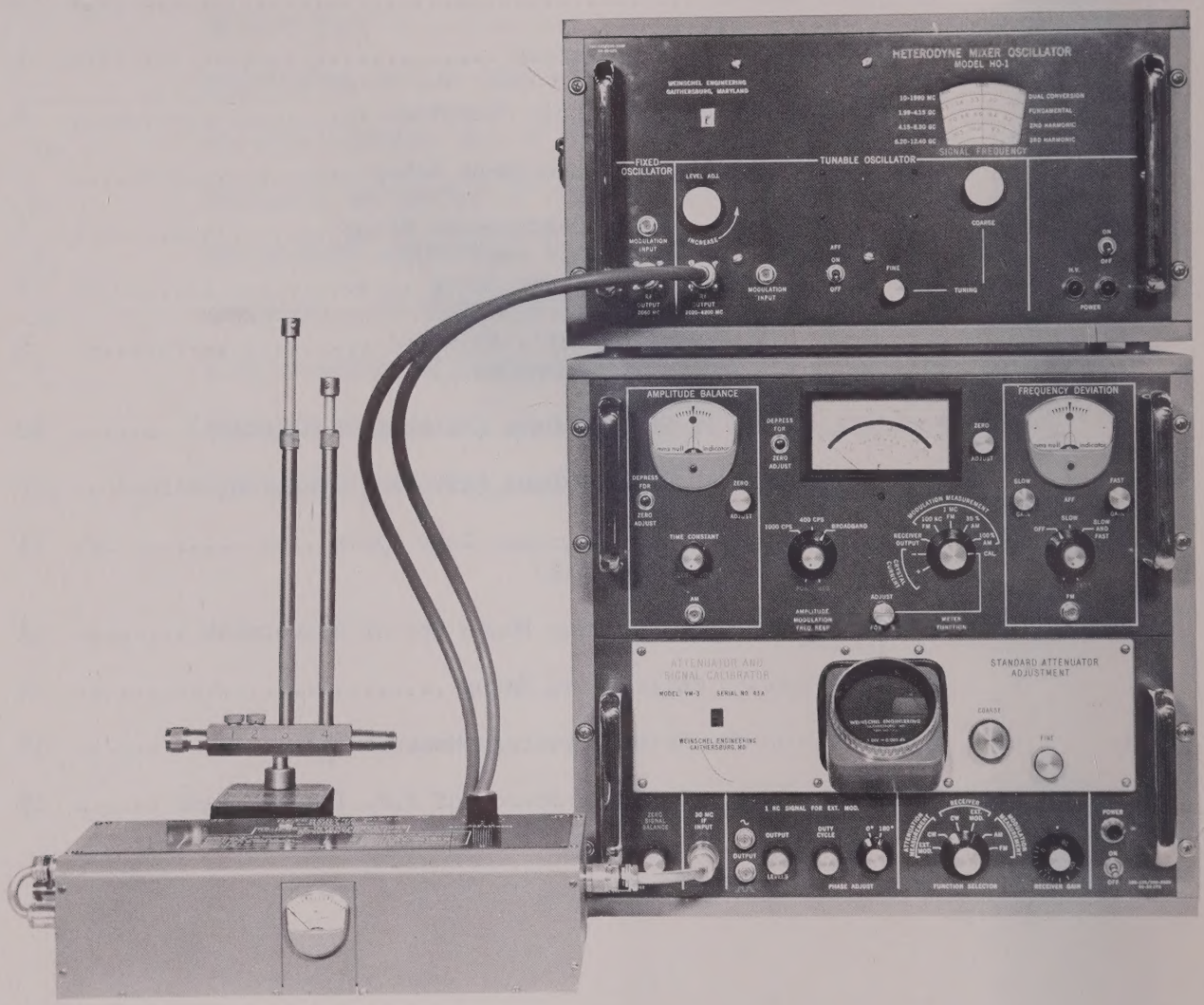


Frontispiece. VM-3/HO-1 System

OPERATION AND MEASUREMENT PROCEDURES

WEINSCHEL ENGINEERING MODEL VM-3/HO-1 INSERTION LOSS MEASURING SYSTEM

Introduction

This instruction manual was written to assist the user of a VM-3/HO-1 System in the selection of compatible accessory equipment and to provide step by step set-up and measurement procedures. The operator should, however, be familiar with the operation and function of all accessory equipment and have a working knowledge of microwave measurement techniques.

The Weinschel Model VM-3 is a sensitive 30-mc receiver that employs the parallel IF substitution technique for the accurate measurement of attenuation. Any heterodyne system, operating over a broad frequency range, has the disadvantage of requiring two oscillators and a linear mixer for each frequency band. For the most part, these oscillators are restricted to octave bandwidths necessitating sizeable equipment investment to cover a range from, say, 10mc to 12.4 gc. Weinschel Engineering has greatly reduced this initial investment requirement with the development of the Model HO-1 Heterodyne Mixer-Oscillator which combines with the Model VM-3 to form a completely integrated system that covers the broad frequency range from 10 mc to 12.4 gc with but one mixer and one local oscillator.

The VM-3/HO-1 System not only reduces the initial investment but also saves space, reduces set-up time, simplifies operating procedures, and in addition provides Automatic Frequency Following action (AFF) between LO and signal source over the entire frequency range. AFF is not normally possible below 1000 mc since triode oscillators are widely used at low frequencies and are not electronically tunable.

These advantages however do not come without some sacrifice. The maximum one-step dynamic range is reduced from 100 db with conventional mixers (such as the Weinschel 1507/1508 series) to between 80 and 95 db using the HO-1, depending on the mode of operation. These one-step ranges can be extended using partial RF substitution, providing RF signal sources similar to the Weinschel MS series are used. These sources have higher power available than that normally obtainable from the ordinary signal generator.

In addition to the VM-3/HO-1 combination, the only accessories required for a complete measurement set-up, are signal sources covering the frequency ranges of interest and a few waveguide or coax components in the same frequency ranges.

Charts are provided in the back of this book to aid in the proper selection of components necessary for operating the system in the various frequency bands between 10 mc and 12.4 gc. Block diagrams are included for both waveguide and coaxial systems to help in setting up and adjusting the system.

For the theory of operation and maintenance of the various electronic units, refer to the individual Instruction Manuals.

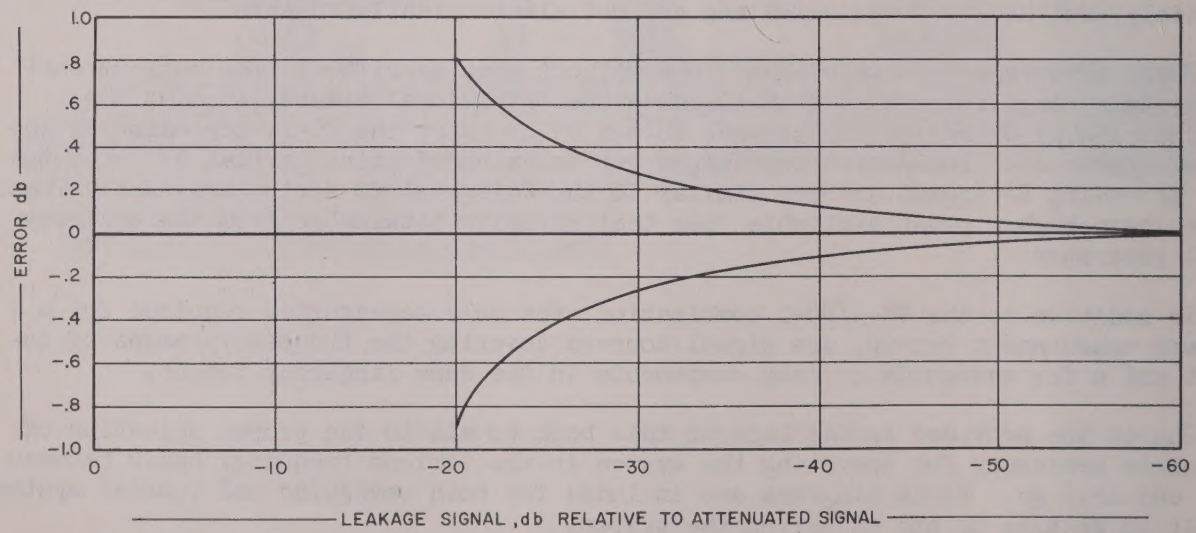
NOTE

The tables listed in the back of this manual are intended for use as a guide in selecting suitable components and do not constitute and endorsement by Weinschel Engineering. Selection of any component from the tables should be made on the basis of both mechanical and electrical charateristics with careful consideration to the precautions described below.

PRELIMINARY SET-UP PRECAUTIONS

When high-resolution measurements are made in a microwave system, past experience with microwave hardware and one's individual measurement techniques become invaluable assets. This is especially true when the Model HO-1 Heterodyne Mixer Oscillator is used in conjunction with the Model VM-3 Attenuator and Signal Calibrator. The high accuracy of the optical readout system of the VM-3 bring out the shortcomings of many RF components which might have seemed adequate in lesser systems. For this reason, we would like to point out some of the problems which could arise in the external RF setup.

When RF power ratio measurements are made over a large dynamic range (20 db or more), precautions must be taken against errors due to leakage. Due to the high detection sensitivity of the HO-1/VM-3 system, the signal level difference between the generator and the HO-A signal input might be as high as 95 db. Let us assume that the leakage signal into the HO-A signal input is 130 db below the generator output level. Let us further assume that a 10 db attenuator should be measured in a system where the HO-A input level is 90 db below the generator output level. With the attenuator under test removed from the system, the leakage signal is 40 db below the measurement signal. With the 10 db attenuator inserted, the leakage signal is only 30 db below the measurement signal, which might cause a maximum error of 0.2 db as seen from the chart.



Leakage can be caused by unshielded RF sources (badly shielded signal generators, leaky RF cavities, improperly bypassed supply leads to microwave oscillators, etc.), improperly shielded RF cables, badly mounted cable connectors, bent waveguide flanges, microwave components with large openings such as slide screw tuners, certain variable attenuators, slotted lines, wavemeters, etc.

During insertion loss measurements, the device under test must be physically removed and reinserted into the transmission system. To obtain good repeatability (0.01 db or better) compatible with the attainable repeatability of the Model VM-3, proper alignment is mandatory. Fixtures such as the Weinschel Model MB-1 Measurement Bench or precision optical benches for waveguide setups are very helpful.

To obtain stable operation in any RF measurement system, the following rules-of-thumb must be observed:

* Coaxial connectors must engage correctly.

* Type N connector gaskets must be removed for metal-to-metal contact.

* The slotted male outer conductor of type N connectors must be straight.

* The slotted female fingers of type N connectors must be bent inward properly.

* Components must be supported at small enough intervals to avoid excessive sag.

* The laboratory work bench must be sturdy enough to prevent the transmission of microphonics to the setup.

* Waveguide flanges must be free of nicks and burrs and connected with waveguide screws of the correct type.

In short, the entire setup must be as rigid and well supported as possible, and there must be no sag, stress, or unnecessary flexing of the system.

The use of high quality components and connectors cannot be over-emphasized, and will determine whether the entire dynamic range of the instrumentation can be realized.

Some additional precautions center around the use of internal cavity klystrons for use at the higher frequencies. In this area vibrations even from blower motors can cause considerable klystron noise. Water cooling is recommended in conjunction with stable, low-ripple, regulated klystron power supplies with DC for the klystron filament such as the Weinschel series of power supply modulators and RF sources. Repeller modulation is also recommeded with higher frequency klystrons (above 10 Gc), however,care should also be taken in setting up the frequency and adjusting the modulation signal. The klystrons should be tuned so that they operate at the top of their modes and not down on the side of the mode where the output might be erratic. The effects of hum and ripple which cause spurious signals on the output are minimized when operating at the peak of the mode.

1. VM-3/HO-1 INITIAL SET UP PROCEDURE.

1.1 Set the HO-1 controls as follows:

A) Level Adjust - Fully Clockwise
B) AFF Switch - ON
C) Power Switch - OFF

1.2 Make all interconnections between HO-1, HO-A, and VM-3 as in Figure 1.1 (Dual conversion) or Figure 1.2 (Fundamental or Harmonic Operating Mode).

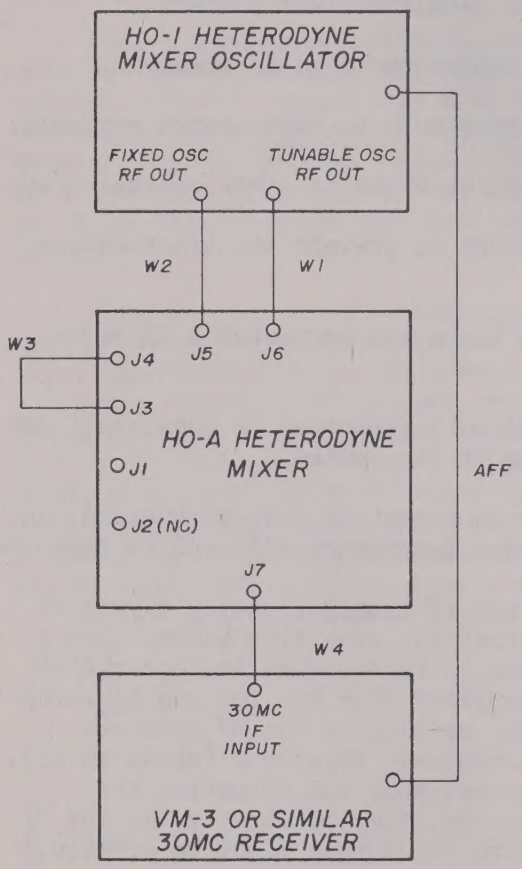


Figure 1.1. Dual Conversion Mode Operation

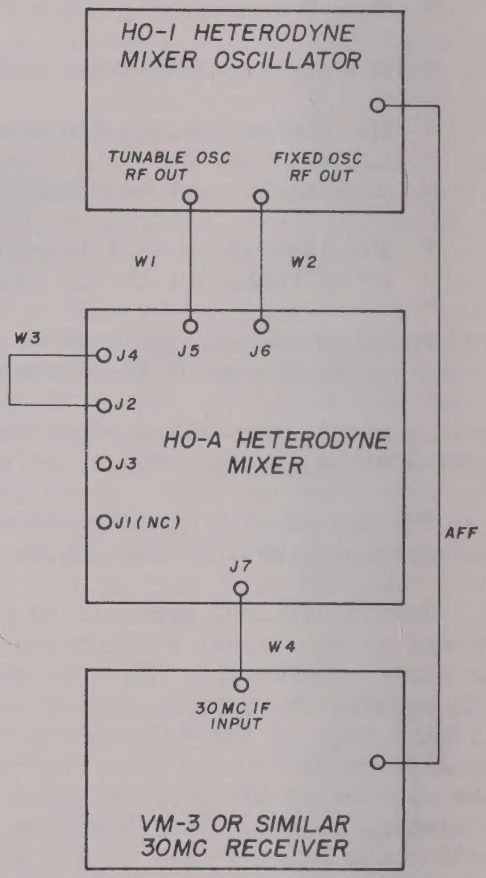


Figure 1.2. Fundamental and Harmonic Mode Operation

1.3 Set the VM-3 controls as follows:

A) AFF - OFF
B) Function Selector - Attenuation Measurements CW or EXT. MOD.
C) Meter Function - Xtal Current (+) or (-)
D) AFF Slow Gain - Full counterclockwise
E) Standard Attenuator - Approximately 125 db

1.4 Connect external components, attenuators, signal generator, etc., as in Figure 1.3 (Coaxial) or Figure 1.4 (Waveguide) and turn HO-1, VM-3, and signal generator power on, allow 5 minutes to warm up.

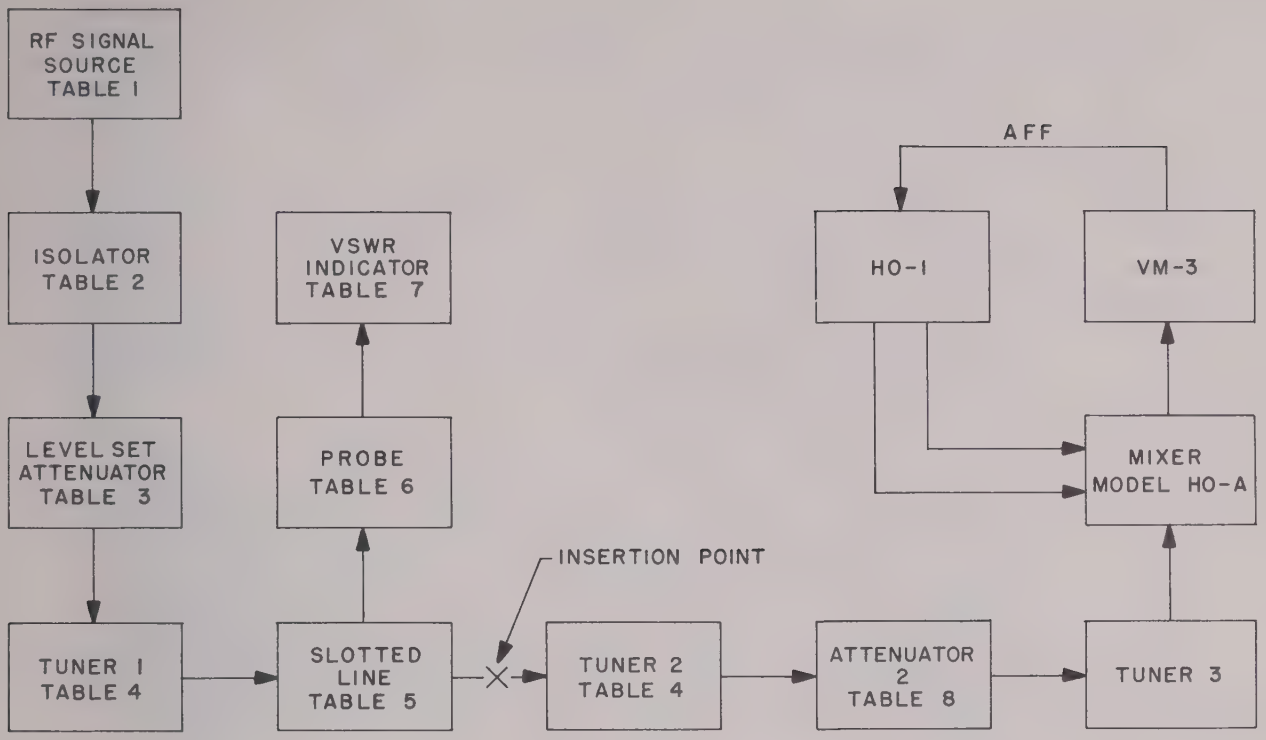


Figure 1.3. Coaxial Insertion Loss Measurement Setup

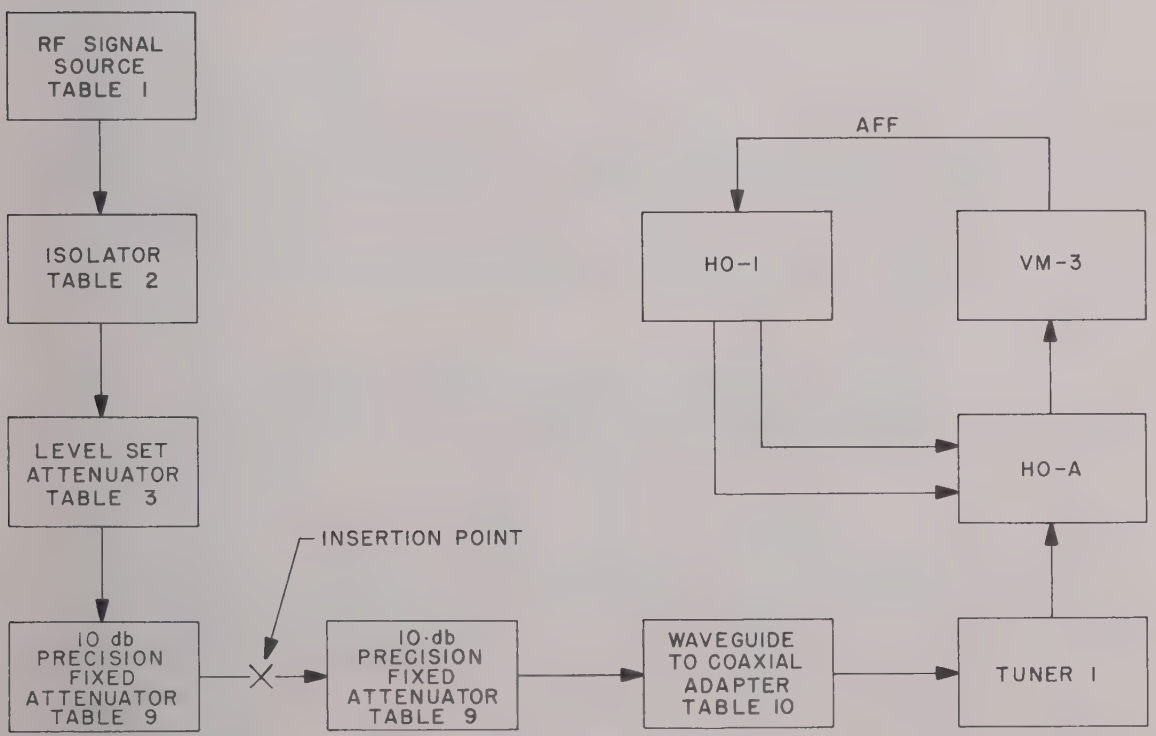


Figure 1.4. Waveguide Insertion Loss Measurement Setup

1.5 Set signal generator to desired frequency with power input to the mixer, approximately -30 dbm.

1.6 Adjust HO-1 coarse tuning to the same frequency indication as signal generator.

1.7 Vary the fine tuning control of the HO-1 until the mixer xtal current peaks on the HO-A meter for dual conversion or the VM-3 meter for fundamental and harmonic operating modes.

1.8 Vary the level adjust on the HO-1 until the proper xtal current is obtained. 1.8 ma for dual conversion; 0.8 ma for fundamental, and 2.0 - 2.2 ma for harmonic.

1.9 Turn the VM-3 AFF switch to the SLOW position.

1.10 Observing the frequency deviation meter on the VM-3, vary the coarse tuning control very slowly in the direction that causes the VM-3 meter to deflect off scale. Continue to vary the frequency in the same direction until the meter swings back through zero. Now vary the frequency in the opposite direction until the meter indicates zero. Vary the piston attenuator until amplitude balance meter indicates approximately zero. Readjust frequency controls until FM meter again indicates zero.

1.11 Turn the AFF switch to off. If there is any change in the frequency deviation meter, adjust R639 on the rear of the VM-3 until there is no change in the meter indication between the slow and off AFF positions.

1.12 Turn the AFF switch to ON and slowly increase the SLOW GAIN control of the VM-3 until the HO-1 locks on frequency. (Too much slow gain will cause the AFF circuit to oscillate and will show up as a rapid fluctuation of the Frequency Deviation meter. Keep the gain setting below this point!) If the Frequency Deviation meter is driven off scale when the SLOW GAIN is increased, reverse the AFF 0^{o}-180^{o} switch.

2. IMPEDANCE ADJUSTMENT OF THE MEASUREMENT CHANNEL.

For the following adjustments it is necessary that the R.F. Signal Source be modulated by 1 Kc signal.

2.1 Set up equipment as shown in Figure 2.1.

2.2 Insert and tune R.F. Probe at the slotted line for maximum indication on the standing wave indicator.

2.3 Adjust tuner No. 1 for an indicated VSWR of less than 1.03:1 from the generator section.

2.4 Set up equipment as shown in Figure 1.3 and connect output of slotted line to tuner No. 2.

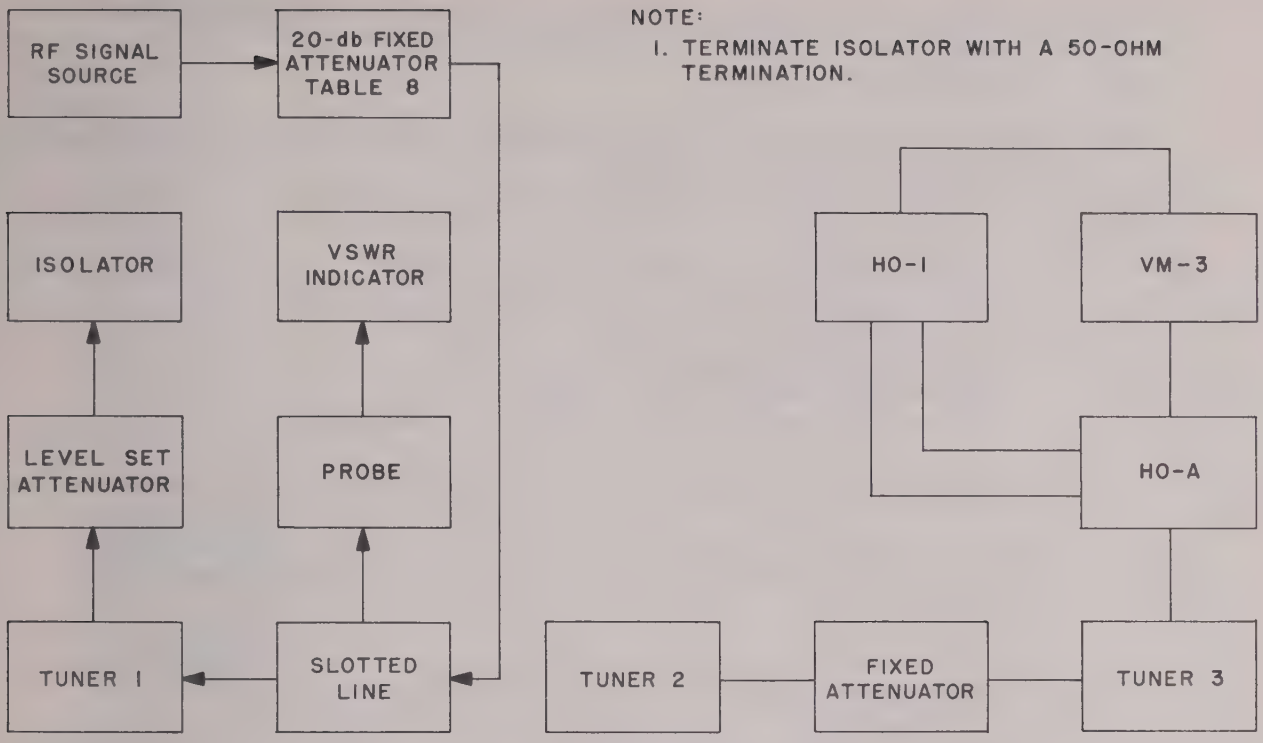


Figure 2.1. Generator Impedance Adjustment Setup

2.5 Repeat Step 2.2.

2.6 Adjust tuner No. 2 for an indicated VSWR of less than 1.03:1 from the measurement section.

2.7 If VM-3 is being operated in the CW attenuation measurement mode, remove the 1 Kc modulation and return the signal generator to CW operation.

2.8 Adjust the frequency of the HO-1 as described in Paragraphs 1.6 through 1.8 of Section 1.

2.9 Set the VM-3 function selector to receiver operation (either CW or modulated, depending on signal generator operation)

2.10 Set meter function switch to receiver output and adjust receiver gain for an on-scale indication.

2.11 Adjust tuner No. 3 for a maximum indication on the VM-3 output meter, adjusting the receiver gain as necessary to maintain an on-scale indication. It will also be necessary to observe the mixer crystal current from time to time to be sure that it does not exceed desired level.

NOTE

For waveguide setup the only impedance adjustment necessary in the adjustment of tuner no. 3 as called out in paragraph 2.11. (Tuner no. 1 in figure 1.4.)

3. PREPARATORY ADJUSTMENTS FOR INSERTION LOSS MEASUREMENTS.

3.1 CW Operating Mode.

3.1.1 Set up equipment as shown in Figure 1.3 or 1.4, and follow procedures outlined in Section 1 and 2.

3.1.2 Set VM-3 controls as follows:

A) AFF - SLOW
B) AFF Slow Gain - Full counterclockwise
C) Function Selector - Attenuation measurement - CW
D) Meter Function - Crystal current
E) Standard Attenuator - 140 db
F) AM Sensitivity - Full clockwise
G) Zero Signal Balance - Full counterclockwise

3.1.3 Set the 30 Mc I.F. matching network on the HO-A full clockwise.

3.1.4 De-tune the R.F. Signal Source off frequency and set the output attenuator to maximum attenuation or insert an additional 120 db in the line.

3.1.5 Vary the Tuning Control on the VM-3 until a null is indicated on the FREQUENCY DEVIATION meter of the VM-3.

3.1.6 Increase the ZERO SIGNAL BALANCE control until a null is indicated on the AMPLITUDE BALANCE meter of the VM-3.

3.1.7 Turn the 30 Mc I.F. MATCHING NETWORK control to lower the step number, and simultaneously adjust the ZERO SIGNAL BALANCE control until a reasonably stable null is obtained on the AMPLITUDE BALANCE meter. More than onenull will be found; use that which requires the smallest clockwise rotation of the ZERO SIGNAL BALANCE control.

NOTE

Interaction between the amplitude balance adjustment just completed and the frequency adjustment is normal. The TUNING control and the ZERO SIGNAL BALANCE control should be readjusted as required to properly null each meter indication. If the AMPLITUDE BALANCE and FREQUENCY DEVIATION nulls are not reasonably stable, leakage from another source operating at the same frequency should be investigated.

NOTE

Do not adjust the controls on the HO-1 after the preceding procedure has been completed.

3.1.8 Remove the attenuation inserted in step 3.1.4 and return the R.F. Signal Source to the desired frequency.

3.1.9 Set the VM-3 standard attenuator to approximately 35 db.

3.1.10 Vary the frequency of the R.F. Signal Source until a null is obtained on FREQUENCY DEVIATION meter and increase the AFF - SLOW GAIN until lock-on is obtained.

3.2 External Synch or Modulation Operating Mode.

3.2.1 Set up the equipment as shown in Figure 1.3 or 1.4, and follow procedures outlined in Sections 1 and 2.

3.2.2 Set VM-3 controls as follows:

A) AFF - SLOW
B) AFF Slow Gain - Full counterclockwise
C) Function Selector - Attenuation Measurement - External Modulation
D) Meter Function - Crystal current
E) Standard Attenuator - Approximately 35 db
F) Zero Signal Balance - Full counterclockwise

3.2.3 Connect the 1 Kc sine wave (for external synch) or square wave (for external modulation) output of the VM-3 to the R.F. Signal Source.

3.2.4 Set frequency of HO-1 and R.F. Signal Source as in Paragraphs 1.6 through 1.8 of Section 1.

3.2.5 Observe the AM output waveform on an oscilloscope.

3.2.6 Adjust the R.F. level into the Mixer to approximately -35 dbm.

3.2.7 Adjust the DUTY CYCLE control on the VM-3 until a symmetrical square wave is produced.

3.2.8 Adjust the STANDARD ATTENUATOR until a straight line output is obtained as shown in Figure 3.1. If a balance cannot be obtained, check Figures 3.2, 3.3, 3.4, or 3.5 to determine problem and perform corrective measures as called out beneath each figure.

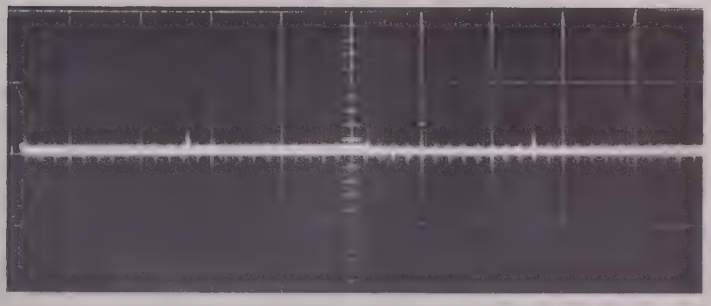


Figure 3.1 Duty Cycle and Phase Correctly Adjusted (External synch or external mod.)

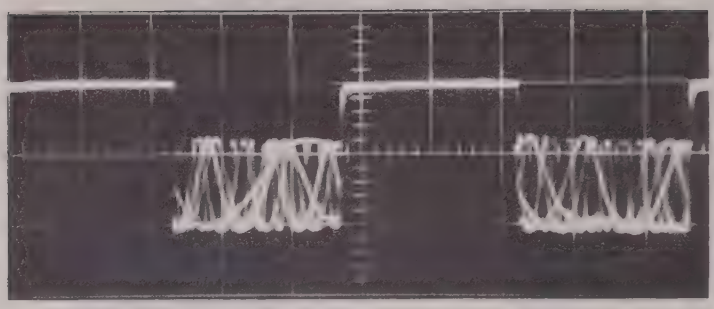


Figure 3.2

MODULATIONS NOT IN COUNTERPHASE
(EXTERNAL MODULATION)
Reverse 1 Kc 0°/180° Phase Adjust Control on VM-3

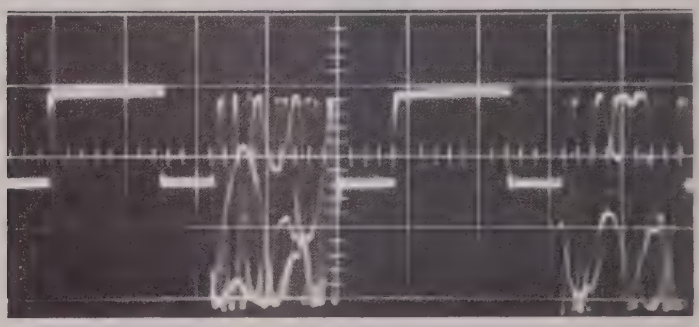


Figure 3.3

MODULATIONS NOT IN COUNTERPHASE
(EXTERNAL SYNCHRONIZATION)
Reverse 1 Kc 0°/180° Phase Adjust Control on VM-3

3.2.9 Set VM-3 controls as follows:

A) Function Selector - Receiver - External Modulation
B) Meter Function - Receiver output
C) Receiver Gain - 75

3.2.10 Adjust the HO-A 30 Mc I.F. matching network and the VM-3 tuning control for a maximum indication on the VM-3 output meter, vary

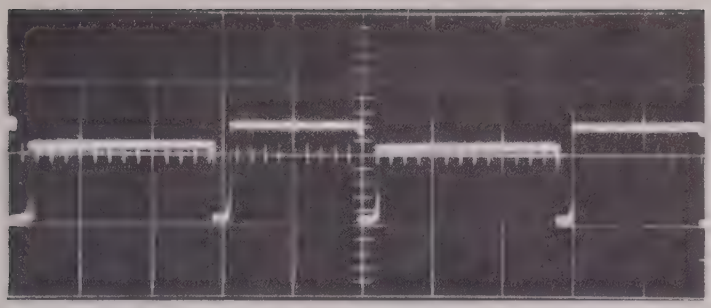


Figure 3.4

MODULATIONS PHASED, BUT IMPROPER DUTY CYCLE
(EXTERNAL SYNCHRONIZATION)
Adjust 1 Kc Duty Cycle Control on VM-3

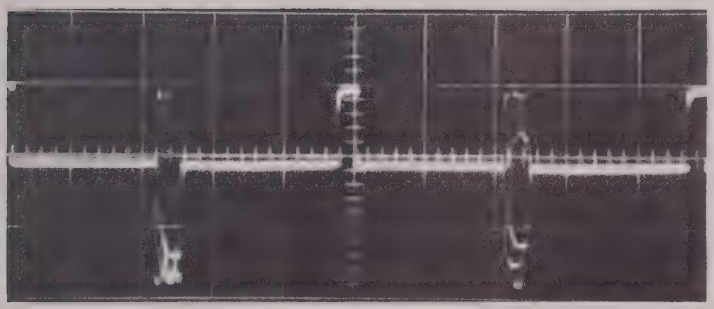


Figure 3.5

DUTY CYCLE CORRECT, BUT FINE PHASE OUT OF ADJUSTMENT
(EXTERNAL SYNCHRONIZATION)
Adjust 1 Kc Fine Phase Control on VM-3

the RECEIVER GAIN control as necessary to keep the meter on scale. Occasionally check mixer CRYSTAL CURRENT to maintain the required value.

3.2.11 Recheck the FREQUENCY DEVIATION meter and adjust HO-1 TUNING controls as necessary to obtain a frequency balance and increase the AFF-SLOW GAIN until lock-on is obtained.

4. INSERTION LOSS MEASUREMENTS PROCEDURE.

4.1 Insertion Loss of Fixed Devices.

4.1.1 After making all preparatory adjusts as called out in Sections 1, 2, and 3 and with the equipment set up as in Figure 1.3 or 1.4, the system is now ready to make insertion loss measurements.

4.1.2 Adjust the input level to the mixer so that the VM-3 is operating in its most linear range. (i.e. -35 dbm input to mixer for insertion loss measurements of 10, 20, 30, and 40 db.)

4.1.3 Vary standard attenuator coarse and fine controls until a null is obtained on the amplitude balance meter.

4.1.4 The outer rim around the glass face of the Optical Readout device may be rotated over a full 360 degrees. Rotating the outer rim will also rotate the double line Archimedes spiral on the face of the glass. The rim should be rotated until the double lines of the Archimedes spiral bracket the line division located directly beneath the db figure that appears in the upper right illuminated window on the face of the readout device.

4.1.5 Add the db figure that appears in the upper right window to that which appears in the bottom window. For example, if the db figure in the upper window reads 21 db and the figure in the lower window reads .435, the relative level is 21.435 db.

NOTE

The figures that appear in the bottom window increase from right to left.

4.1.6 Record the db figure obtained in steps 4.1.3, 4.1.4, and 4.1.5.

4.1.7 Turn AFF OFF.

4.1.8 Break connection at insertion point and insert unknown.

4.1.9 Vary standard attenuator coarse control until AMPLITUDE BALANCE meter approaches a null.

4.1.10 Turn AFF ON. Repeat steps 4.1.3 through 4.1.6.

4.1.11 The difference between the db figures obtained in step 4.1.6 and 4.1.10 is the insertion loss of the unknown.

4.2 Insertion Loss of Variable Devices.

4.2.1 Set up equipment as in Figure 1.3 or 1.4 and perform steps 4.1.1 through 4.1.10.

4.2.2 The difference between the db figures obtained in steps 4.1.6

and 4.1.10 is the zero insertion loss of the unknown.

4.2.3 With the device inserted in the system, repeat steps 4.1.3 through 4.1.6.

4.2.4 Set the variable device to the desired indication and readjust the standard attenuator for a null on the AMPLITUDE BALANCE meter and repeat steps 4.1.4 through 4.1.6.

4.2.5 The difference between the db figures obtained in 4.2.3 and 4.2.4 is the incremental attenuation inserted into the variable device above the zero insertion loss.

4.3 Extending the Dynamic Range by Partial R.F. Substitution.

4.3.1 Set up the system as in Figure 1.3 or 1.4.

4.3.2 Accurately determine the insertion loss of a fixed attenuator as in Section 4.1.

4.3.3 Insert the calibrated attenuator into the system at the insertion point.

4.3.4 Repeat steps 4.1.2 through 4.1.6.

4.3.5 Turn the AFF OFF, remove the calibrated attenuator, and insert the unknown.

4.3.6 Repeat steps 4.1.9 through 4.1.10.

4.3.7 The difference between the db figures obtained in steps 4.3.4 and 4.3.6 plus the insertion loss of the calibrated attenuator is the insertion loss of the unknown.

5. SIGNAL GENERATOR CALIBRATION.

5.1 Calibration of Output Attenuator.

5.1.1 Set up the equipment as in Figure 5.

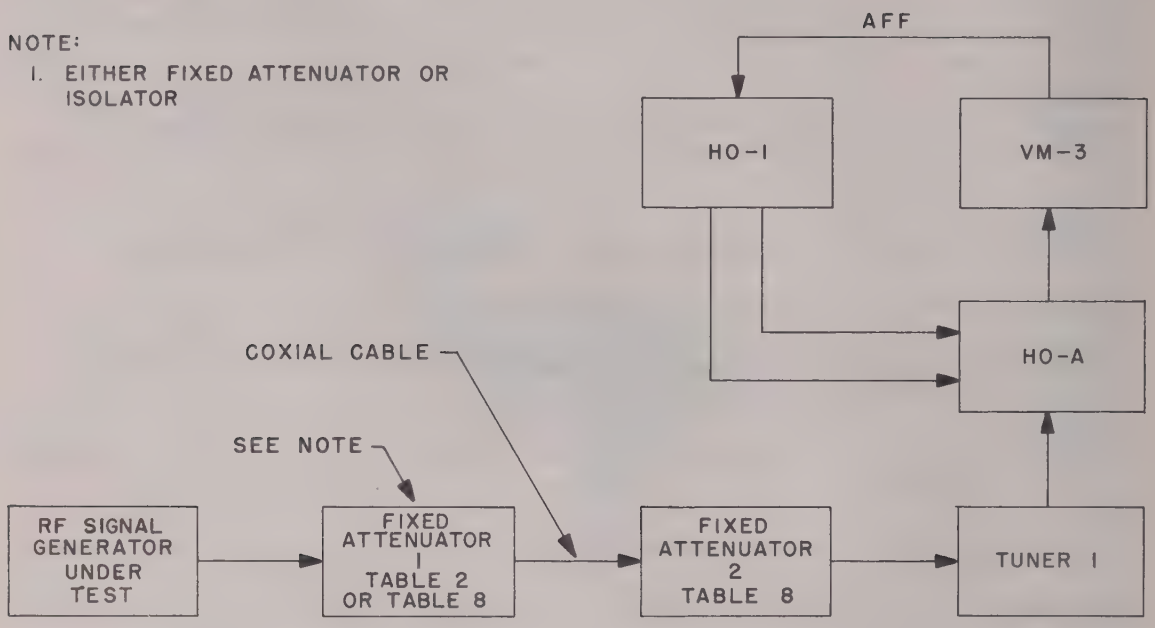


Figure 5. Signal Generator Calibration Setup

5.1.2 Perform all necessary preparatory adjustments as called for in Sections 1, 2, and 3.

5.1.3 Set Generator Output Attenuator to "0 dbm" position and adjust level control to the "set point" on the GENERATOR OUTPUT meter.

5.1.4 Repeat steps 4.1.2 through 4.1.6.

NOTE

In step 4.1.2 do not adjust the level to the mixer with the Signal Generator Attenuator. Use external attenuation between the mixer and signal generator to obtain -35 dbm input.

5.1.5 Increase generator output attenuator to desired indication.

5.1.6 Readjust LEVEL SET control to "set point" on generator.

5.1.7 Repeat steps 4.1.3 through 4.1.6.

5.1.8 The difference between the db figures obtained in 5.1.4 and 5.1.7 is the incremental attenuation inserted in the output attenuator.

NOTE

After the Signal Generator Attenuator has been calibrated up to 50 db, remove all but 10 db of the external attenuation between the signal generator and the mixer. This will allow incremental calibrations from an indicated -50 dbm on the generator attenuator over an additional range of about 40 db, depending on the mode of operation used on the HO-1.

NOTE

Signal generator may be operated either CW or external mod., taking precautions to perform proper procedures as called out in Section 3.

5.2 Calibration of Percent AM Modulation.

5.2.1 Set up equipment as shown in Figure 5.

5.2.2 Follow the procedures outlined in Section 1, Paragraphs 1.5 through 1.12, and set mixer input level to approximately -50 dbm.

5.2.3 Set FUNCTION SELECTOR to MODULATION MEASUREMENT - AM. Set METER FUNCTION to CAL.

5.2.4 Depress the depress for ZERO ADJUST switch and vary the ZERO ADJUST control until VM-3 output meter indicates zero.

5.2.5 Vary ADJUST for F.S. control until the VM-3 output meter indicates full scale.

5.2.6 Turn Signal Generator Function selector to desired modulation position and adjust percent modulation control until modulation meter indicates percent modulation desired. (i.e. 30%, 50%, etc.)

5.2.7 Adjust SIGNAL GENERATOR LEVEL SET control to indicate "set point" on the GENERATOR OUTPUT meter.

5.2.8 Turn VM-3 meter function selector to MODULATION MEASUREMENT -35% AM or 100% AM, whichever is required.

5.2.9 Set AMPLITUDE MODULATION FREQ. RESP. to proper position, 1000 cps, 400 cps, or broadband.

5.2.10 The VM-3 output meter will now indicate the percent AM modulation of the generator signal.

NOTE

To determine what, if any, percent of the AM is due to frequencies other than 1000 or 400 cps, set the function selector to broadband and observe the dif-

ference in the VM-3 meter indication. Also by turning the RED knob on the function selector from POS. to NEG., it is possible to determine if there is any distortion of the modulated signal by observing the change on the VM-3 meter.

5.3 Calibration of Incidental FM.

5.3.1 Repeat steps 5.2.1 through 5.2.5. Except in 5.2.3, set function selector to MODULATION MEASUREMENT - FM.

5.3.2 Set Signal Generator Function Selector to CW.

5.3.3 Turn VM-3 Meter Function Selector to MODULATION MEASUREMENT - 1Mc FM and the RED knob on the MODULATION FREQ. RESP. to NEG.

5.3.4 Observe the VM-3 output meter for the peak to peak FM indication. If the indication is below 10 on the output meter, switch the meter function selector to 100 Kc FM.

NOTE

The 100 Kc and 1 Mc FM positions of the meter function selector are full scale peak to peak FM indications.

6. RECEIVER OPERATION.

6.1 CW Signal Source.

6.1.1 Set up the VM-3/HO-1 as in Figure 1.1 or 1.2.

6.1.2 Connect Signal Generator and components as in Figure 5.

6.1.3 Follow the procedures outlined in Section 1, Paragraphs 1.5 through 1.12.

6.1.4 Set the function selector to RECEIVER - CW and the meter function to RECEIVER OUTPUT.

6.1.5 Turn the signal source OFF and adjust the ZERO SIGNAL BALANCE control for minimum indication on the main meter. Turn the signal source ON.

6.1.6 The HO-1 and VM-3 are now set up to operate as a receiver of CW signals. The minimum discernible signal should be less than -105 dbm depending upon the HO-1 operating mode. For receiver operation at extremely low levels, AFF should not be used; instead, slightly vary the HO-1 FINE TUNING control or signal frequency for maximum indication.

6.1.7 For detection of extremely low signal levels, turn the FUNCTION SELECTOR switch to the ATTENUATION MEASUREMENT CW position and set the standard attenuator to 140 db. Turn the signal source OFF.

6.1.8 Press the DEPRESS FOR ZERO ADJUST button and zero the AMPLITUDE BALANCE meter with the ZERO ADJUST control. Adjust the ZERO SIGNAL BALANCE control for a null on the AMPLITUDE BALANCE meter. Turn the signal source ON.

6.1.9 Extremely low signal levels may now be detected as an indication on the AMPLITUDE BALANCE meter. Note that under these conditions the RECEIVER GAIN control is inoperative and sensitivity is controlled with the red SENSITIVITY control in the AMPLITUDE BALANCE section.

6.2 Modulated Signal Source.

6.2.1 Set up VM-3/HO-1 as in Figure 1.1 or 1.2.

6.2.2 Connect signal generator and components as in Figure 5.

6.2.3 Follow the procedures outlined in Section 3, Paragraphs 3.2.2 through 3.2.11.

6.2.4 The HO-1 and VM-3 are now set up to operate as a receiver of a 1 Kc modulated signal. The minimum discernible signal should be less than -105 dbm, depending upon the HO-1 operating mode. For

receiver operation at extremely low levels, AFF should not be used; instead, slightly vary the HO-1 FINE TUNING control or the signal frequency for maximum indication.

6.2.5 For detection of extremely low signal levels, it is desirable to externally modulate or synchronize the signal with the VM-3 1 Kc signal and make use of the synchronous detector in the VM-3.

6.2.6 Turn the FUNCTION SELECTOR switch to the ATTENUATION MEASUREMENT EXT. MOD. position with the STANDARD ATTENUATOR set to 140 db. Press the DEPRESS FOR ZERO ADJUST button and zero the AMPLITUDE BALANCE meter using the ZERO ADJUST knob.

6.2.7 Extremely low signal levels may now be detected as a deflection of the AMPLITUDE BALANCE indicator. Note that under these conditions the RECEIVER GAIN control is inoperative, and sensitivity is controlled with the red SENSITIVITY control in the AMPLITUDE BALANCE section.

NOTE

The signal generator called for in this procedure is used for initial set up only. Any R.F. Signal Source may be substituted for the generator, as shown in Figures 6.1 and 6.2.

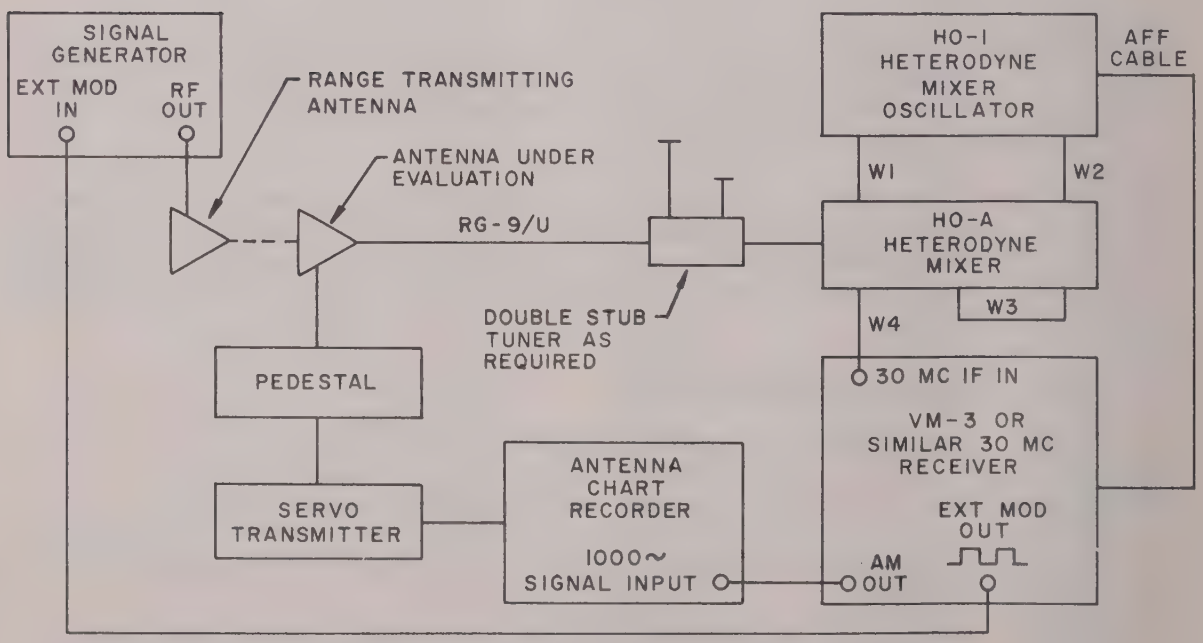


Figure 6.1. Typical Setup for Antenna Pattern Measurement

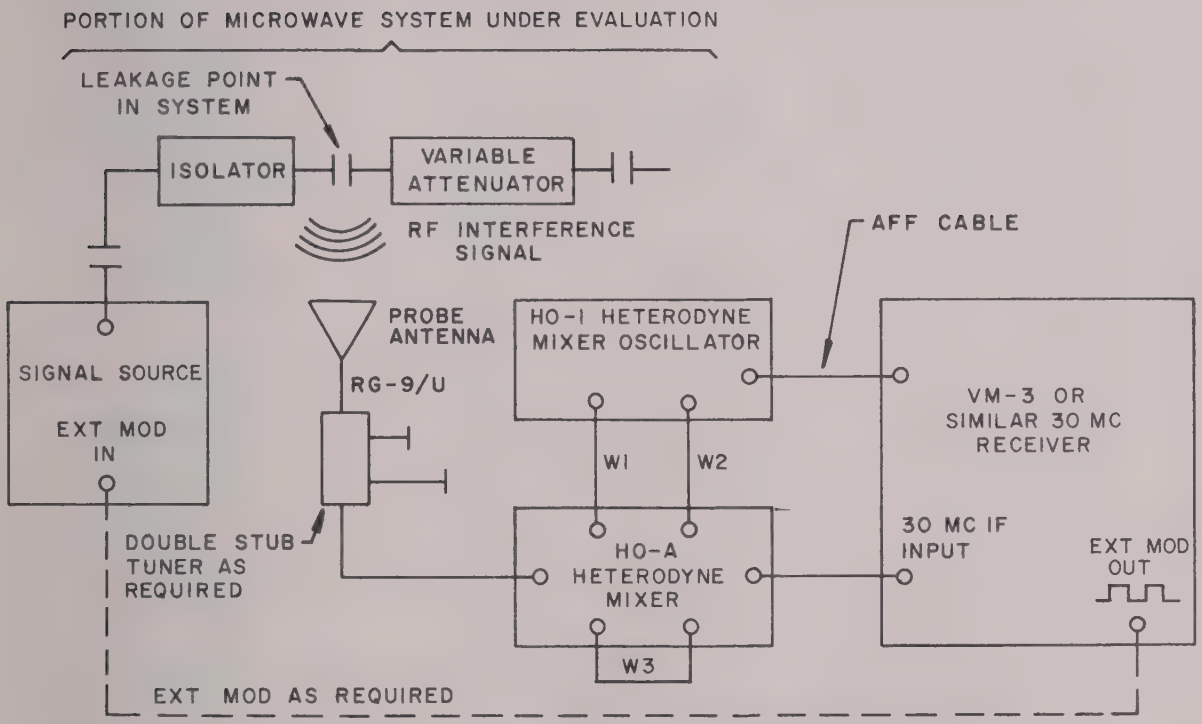


Figure 6.2. Typical Setup for Locating Source of RF Interference

SECTION 7

COMPONENT TABLES FOR MODEL VM-3/HO-1 SYSTEM

The following tables are provided for quick and easy selection of the proper components necessary for operation of the VM-3/HO-1 System:

TABLE 1

R. F. SIGNAL SOURCES

Frequency Range gc	Manufacturer*	Model No.	Power Supply Required
0.01 - 0.480	H-P	608C, D	None
0.01 - 0.05	Weinschel	MS-15	MO-3 or MO-5
0.05 - 0.250	Weinschel	MS-12	MO-3 or MO-5
0.250 - 0.920	Weinschel	MS-13	MO-3 or MO-5
0.450 - 1.230	H-P	612A	None
0.800 - 2.400	H-P	614A	
		8614A, B	None
0.920 - 2.200	Weinschel	MS-8	MO-3 or MO-5
0.950 - 2.400	Polarad	MSG-1	None
1.800 - 4.500	H-P	616B	
		8616A, B	None
2.000 - 4.600	Polarad	MSG-2	None
2.100 - 4.200	Weinschel	MS-9	MO-3 or MO-5
3.800 - 7.600	H-P	618B	None
4.000 - 7.300	Weinschel	MS-10	MO-3 or MO-5
7.000 - 11.000	H-P	620A	None
7.200 - 10.500	Weinschel	MS-11	MO-3 or MO-5
7.500 - 10.000	Weinschel	MS-30	MO-4
8.200 - 12.400	Weinschel	MS-31	MO-4
10.000 - 15.500	H-P	626A	None

*See Code of Manufacturers, Table 11

TABLE 2

ISOLATORS

COAXIAL

Frequency Range gc	Manufacturer* and Model Number		
	E & M Labs	Melabs	Micro. Assoc.
0.5 - 1.0	U115LC1	--	--
1.0 - 4.0	LS110LC1	SYF-3032	--
4.0 - 8.0	C101LC1	SYF-3043	3087
8.0 - 12.0	X140LC1	--	--

*See Code of Manufacturers, Table 11

WAVEGUIDE

Manufacturer*		Model Number
Rantec	Micromega	Consult Manufacturer for Proper Model for your needs.
Airtron	Narda	
Kearfott	PRD	
Cascade	FXR	
Raytheon		
Sylvania		
TRG Inc.		

*See Code of Manufacturers, Table 11

TABLE 3

LEVEL SET ATTENUATORS

Frequency Range Gc	Manufacturer*	Model Number
DC - 1.0	Weinschel	905
1.3 - 11.0**	Weinschel	973-10
2.5 - 11.0	Weinschel	953-10

*See Code of Manufacturers, Table 11
**Useable to 1.0 Gc as level set attenuator

TABLE 4

TUNERS

COAXIAL

Frequency Range gc	Manufacturer*	Model Number
.04 - 0.40	Weinschel	DS-109H
.20 - 2.0	Weinschel	DS-109LL
.40 - 4.0	Weinschel	DS-109L
.75 - 10.0	Weinschel	DS-109

*See Code of Manufacturers, Table 11

WAVEGUIDE

Frequency Range gc	Manufacturer's* Model Number			
	H-P	PRD	Narda	FXR
2.60 - 3.95	S-870-A	309-A	964	S-311-A S-312-A
3.95 - 5.85	G-870-A	300-A	963	H-311-A H-312-A
5.85 - 8.20	J-870-A	305-A	962	C-311-A C-312-A
7.05 - 10.0	H-870-A	302-B	961	W-311-A W-312-A
8.2 - 12.4	X-870-A X-880-A	303-A	960	X-311-A X-312-A
12.4 - 18.0	P-870-A P-880-A	314-A	959	Y-311-A Y-312-A
18.0 - 26.5	K-870-A K-880-A	313-A	958	K-312-B
26.5 - 40.0	R-870-A R-880-A	312-A	V-957	U-312-B
33.0 - 50.0			Q-957	Q-312-B
5.0 - 75.0		323	M-957	M-312-B
60.0 - 90.0			E-957	E-312-B

*See Code of Manufacturers, Table 11

TABLE 5

SLOTTED LINES

COAXIAL

Frequency Range gc	Manufacturer*	Model Number
.0375 - 3.0	Alford	1026B-16**
.1 - 4.0	Alford	2181-6***
.5 - 6.0	Weinschel	1000R
.5 - 4.0	H-P	805-C
.45 - 4.0	Narda	230-N, 230-C, 230-5/8, 230-7/8, 230-SC
1.0 - 4.0	FXR	N-101-A /
1.0 - 4.0	PRD	215-A /
1.5 - 12.4	Narda	231-N, 231-C, 231-TNC /
3.0 - 12.0	H-P	806-B /
4.0 - 10.0	FXR	N-101-B /
4.0 - 10.0	PRD	205-A /

* See Code of Manufacturers, Table 11
/ Requires tuning probe -- See Table 6
** Requires one Type 1122C Type "N" tapered reducer
***Requires one Type 2170 Type "N" tapered reducer

WAVEGUIDE

Frequency Range gc	Manufacturer's** Model Number			
	FXR	Narda	H-P	PRD
2.60 - 3.95	S-101-A /	224 /	S-810 /	209-A /
3.95 - 5.85	H-101-A /	223 /	G-810-B/ /	201-A /
5.85 - 8.2	C-101-A /	222 /	J-810-B/ /	204-B /
7.05 - 10.0	W-101-A /	221 /	W-810-B/ /	202-B /
8.2 - 12.4	X-101-A /	220 /	X-810-B/ /	203-D /
12.4 - 18.0	Y-102-A	219	P-810-B/ /	210-A
18.0 - 26.5	K-102-A	218*	K-815-B/ /	211-A
26.5 - 40.0	U-102-A*	V-217*	R-815-B/ /	212-A
33.0 - 50.0	Q-103-A*	Q-217*		
50.0 - 75.0	M-103-A*	M-217*		216
60.0 - 90.0	E-103-A*	E-217*		

* Requires Detector Mount
**See Code of Manufacturers, Table 11
/ Used with Universal Probe Carriage
/ Requires tuning probe -- See Table 6

TABLE 6

PROBES

Frequency Range gc	Manufacturer*	Model Number
1.0 - 12.4	FXR	B-200-A tunable
1.0 - 12.4	PRD	250-A tunable
.9 - 18.0	Narda	229 tunable
3.0 - 18.0	H-P	444-A untuned
18.0 - 40.0	H-P	446-B untuned

*See Code of Manufacturers, Table 11

TABLE 7

VSWR INDICATORS

Manufacturer*	Model Number
H-P	415-C
PRD	277B
FXR	B-812-A
Narda	441B

*See Code of Manufacturers, Table 11

TABLE 8

FIXED ATTENUATORS

Frequency Range gc	Manufacturer*	Model Number
DC - 1.5	Weinschel	10
DC - 3.0	Weinschel	50
DC -12.4	Weinschel	1
DC -18.0	Weinschel	2
1.0 -12.4	Weinschel	530
1.0 -12.4	Weinschel	210

*See Code of Manufacturers, Table 11

TABLE 9

PRECISION FIXED ATTENUATORS

Frequency Range gc	Manufacturer* & Model No.
2.6 - 3.95	H-P S372C
3.95 - 5.85	H-P G372C
5.85 - 8.2	H-P J372C
7.05 - 10.0	H-P H372C
8.2 - 12.4	H-P X372C

*See Manufacturers Code, Table 11

TABLE 10

WAVEGUIDE TO COAX ADAPTER

Frequency Range gc	Manufacturer* and Model Number	
	H-P	Narda
2.60 - 3.95	S281	614A
3.95 - 5.85	G281	613A
5.85 - 8.2	J281	612A
7.05 - 10.0	H281	611A
8.2 - 12.4	X281	601A

*See Manufacturers Code, Table 11

TABLE 11

CODE OF MANUFACTURERS*

ABBREVIATION	MANUFACTURER'S NAME AND ADDRESS
Aircom	Aircom, Inc. 48 Cummington Street Boston, Mass.
Airtron	Airtron, Inc. 200 East Hanover Avenue Morris Plains, New Jersey
Alford	Alford Manufacturing Company 299 Atlantic Avenue Boston, Mass.
Am. Elect. Lab.	American Electronics Labs., Inc. 121 N. 7th Street Philadelphia 6, Penna.
Bird	Bird Electronics Corp. 1800 East 38th Street Cleveland, Ohio
BJ Electronics	BJ Electronics, Division of Borg-Warner, Corp. 3300 Newport Blvd. Santa Ana , California
Cascade	Cascade Research 5245 San Fernando Road, W. Los Angeles, California
FXR	FXR, Inc. 25-26, 50th Street Woodside 77, New York
H-P	Hewlett-Packard Co. 1501 Page Mill Road Palo Alto, California
Kearfott	Kearfott Division General Precision, Inc. 14844 Oxnard Street Van Nuys, California

*This list does not constitute an Endorsement.

TABLE 11 (Cont.)

ABBREVIATION	MANUFACTURER'S NAME AND ADDRESS
Micro Assoc.	Microwave Associates, Inc. Burlington, Mass.
Micromega	Micromega Corp. 4134 Del Rey Avenue Venice, California
Narda	Narda Microwave Corp. 118-160 Herricks Road Mineola, New York
PRD	PRD Electronics, Inc. 1200 Prospect Avenue Westbury, L.I., New York
Rantec	Rantec Corp. Craftsman Center Calabassas, California
Raytheon	Raytheon Co. Microwave and Power Tube Division Waltham 54, Mass.
Sierra	Sierra Electronic Corp. 3885 E. Bohannon Drive Menlo Park, California
Sperry	Sperry Microwave Electronics Co. P. O. Box 1828 Clearwater, Florida
TRG	TRG Inc. 2 Aerial Way Syosset, New York
Varian	Varian Associates 611 Hansen Way Palo Alto, California